Factors Affecting the Performance of a Survey Bottom Trawl

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- Henry Milliken- NEFSC, NMFS, initially contacted more than 40 members of the ICES, Fishing Gear and Fish Behavior Working Group.

- Claire Steimle- NMFS Sandy HooK Laboratory, conducted a computer literature search.

Presentation Outline

- Factors affecting trawl survey variability
- General and specific questions to be addressed
- Bottom trawl system and the effect of a warp offset
- Search of literature
- Canvass of experts
- Summary and Conclusions

Factors Affecting Variability in Trawl Survey Data and Results

- Measurement variability due to variability in survey trawl performance.
- Spatial variability due to fish availability as fish are contagiously distributed.
- Environmental variability interacts with both trawl performance and fish availability to the survey trawl.

Reference: Byrne, Azarovitz, and Sissenwine, 1981

General Questions Related to Bottom Survey Trawl Performance

- What is the effect of net design?
- What is the effect of trawl rigging including doors, ground gear, net sweep and flotation, etc,?
- What is the effect of trawl operation including towing speed, current speed and direction relative to tow direction, sea state, etc.?
- What are the effects of fish behavioral response to the gear including day/night differences, habitat differences on sweep capture efficiency, etc.?

Specific Question Related to Bottom Survey Trawl Performance

- What is the effect of an offset or differential in the length of the towing warp?

Measures of Bottom Survey Trawl Performance

- Catch efficiency (catchability) is the most important factor.
- Trawl system geometry including door spread, wing spread and vertical opening of the net mouth.

Evaluation of Bottom Survey Trawl Performance: Standard versus Altered Configuration

- Catch efficiency
  - At sea observations of trawl capture process by divers or with underwater video.
  - On deck catch comparisons.
- Measurements of trawl system geometry using model or full-scale gear.

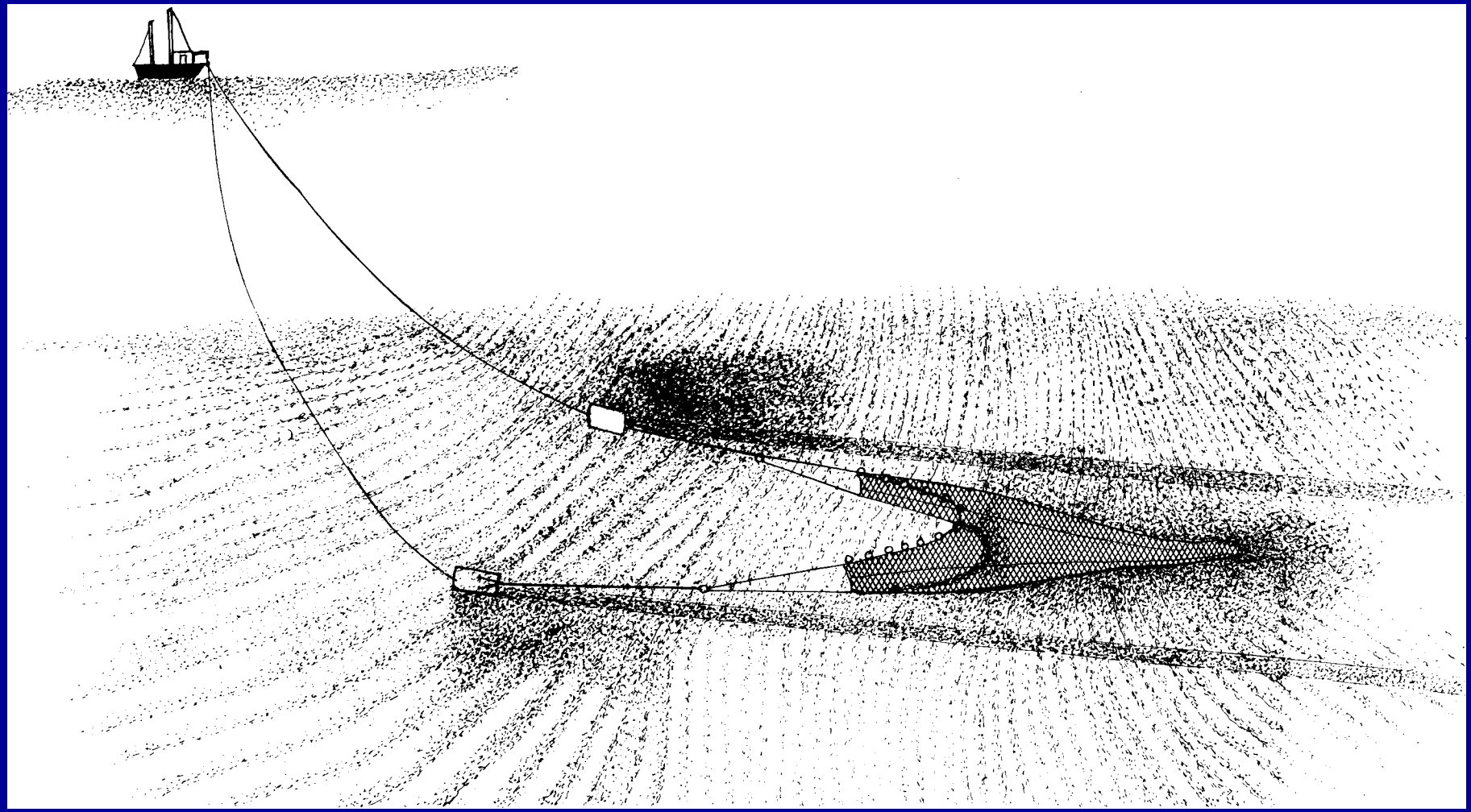
Goal with Regard to Bottom Survey Trawl Performance

- Consistent catch efficiency so that at a given survey station, catch retained in the codend truly reflects fish abundance and size distribution at that location.

Bottom Trawl System

- System of flexible lines that transfer towing force from the vessel to the webbing in the net.
- Components: towing warp, otter boards, ground gear and net bridles, and net headrope and footrope/sweep, and webbing.
- A feedback system exists to balance forces that are temporarily unbalanced adjusting warp caternaries, door angle of attack, and headrope and footrope/sweep caternaries.

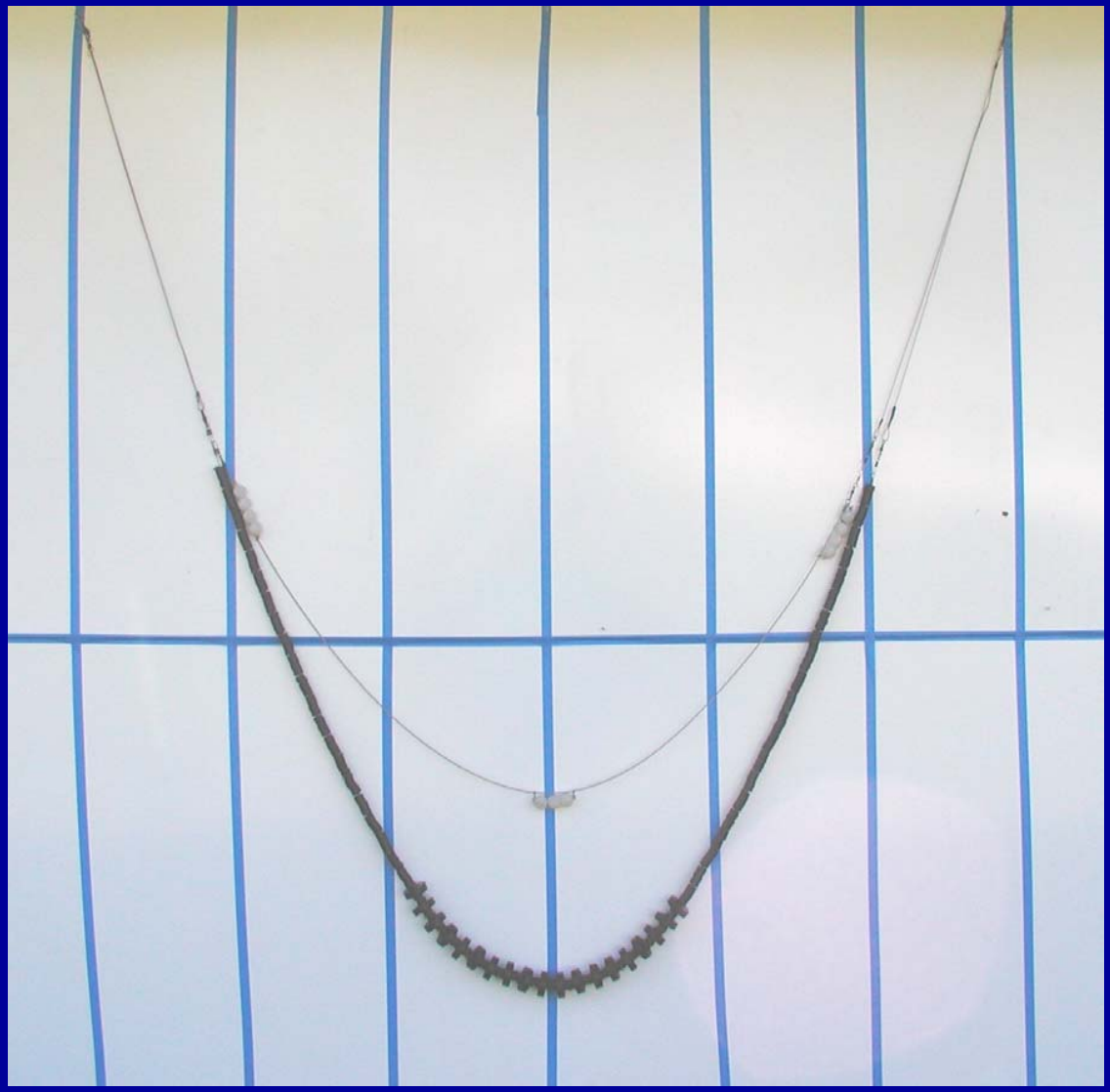
Bottom Trawl System: Towing Vessel, Warp, Otter Boards, Ground Gear, and Net Headrope, Sweep and Webbing



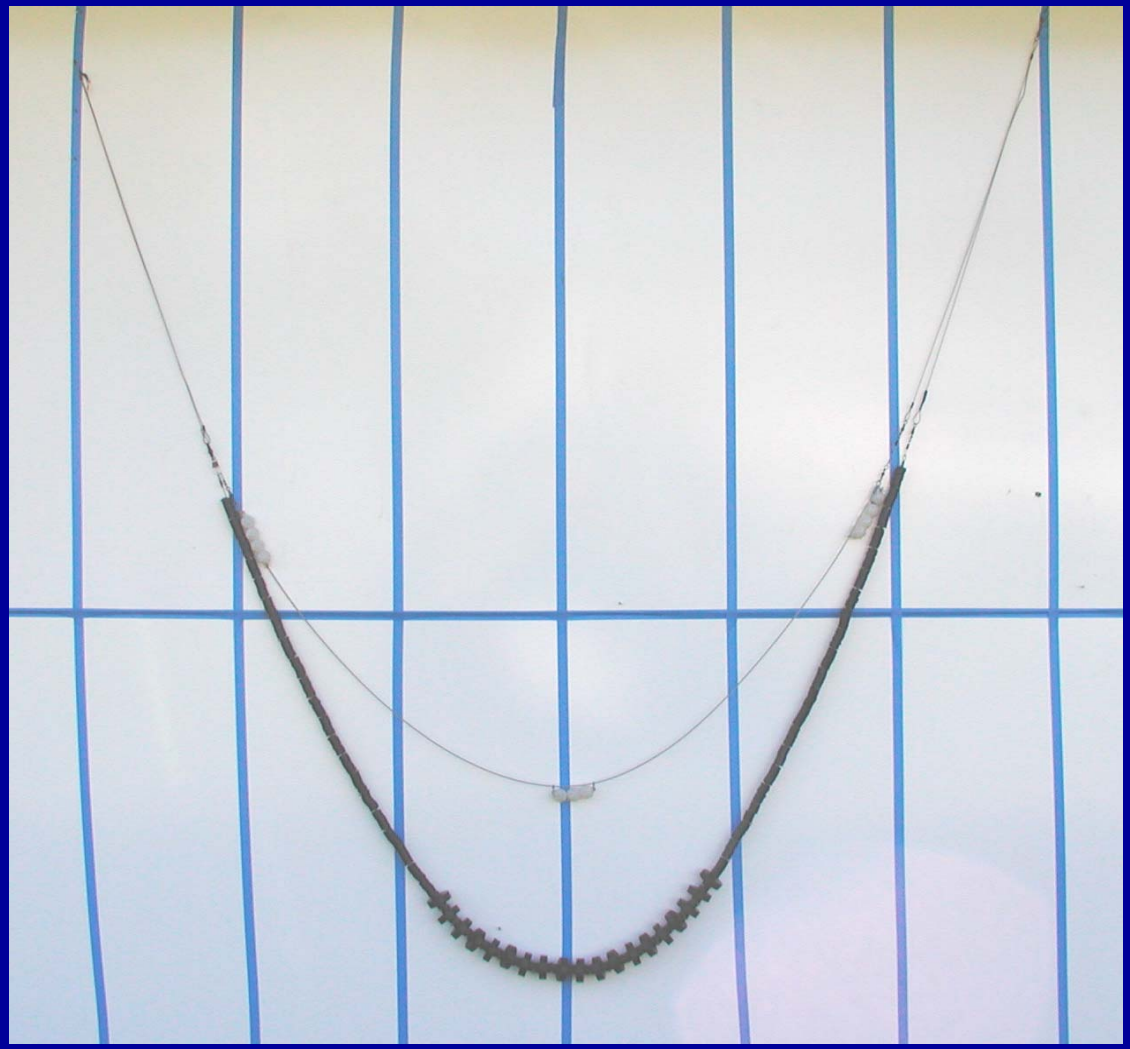
Effect of a Warp Length Offset on Trawl Mouth Geometry

- Standard configuration: equal warp length to the otter boards, 9 ft. backstraps, 30 ft. bridles, 60 ft. headrope and 80 ft. sweep.
- Altered configurations:
  - 3 foot offset
  - 6 foot offset
  - 9 foot offset

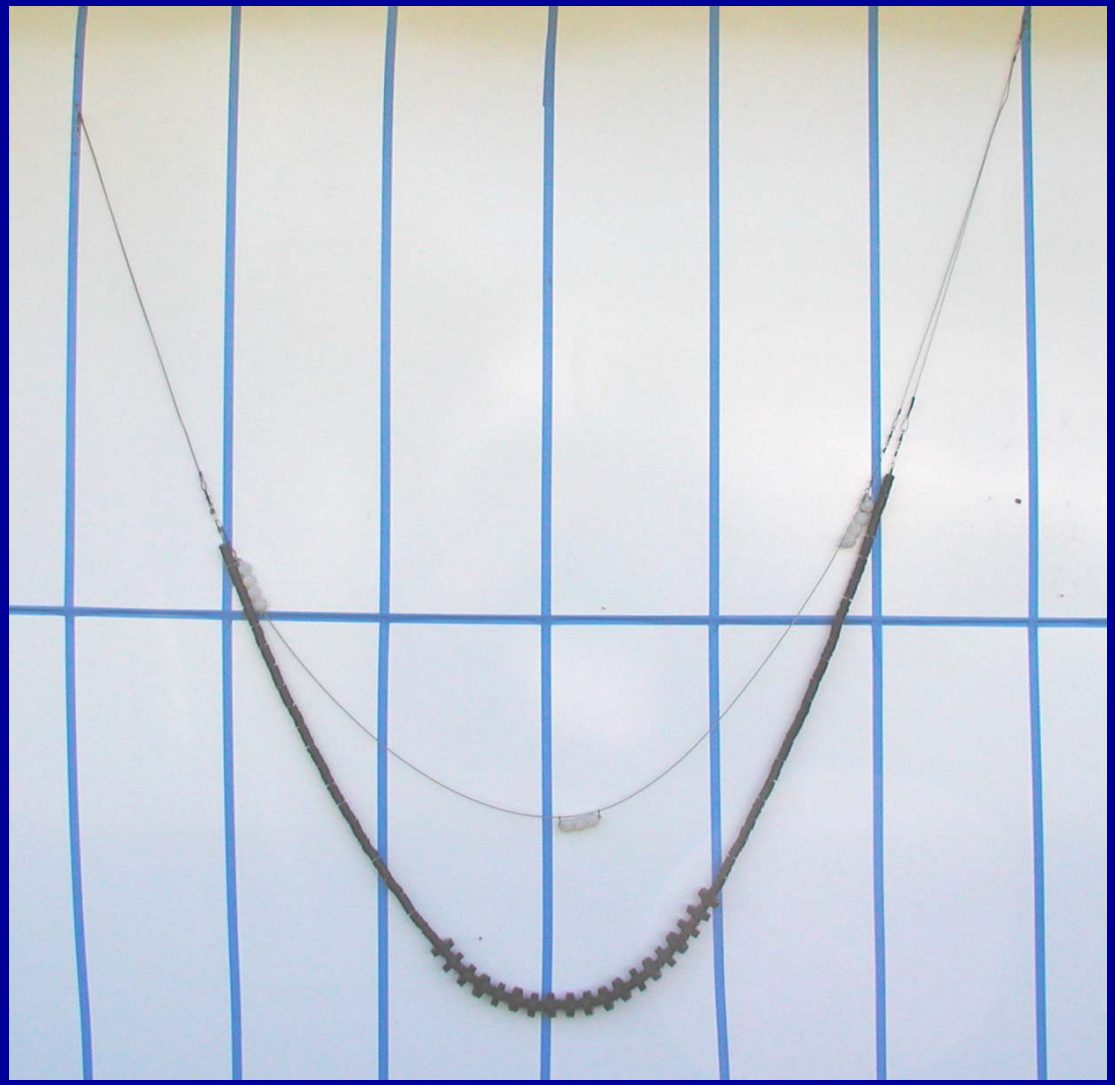
No Offset in Warp Length



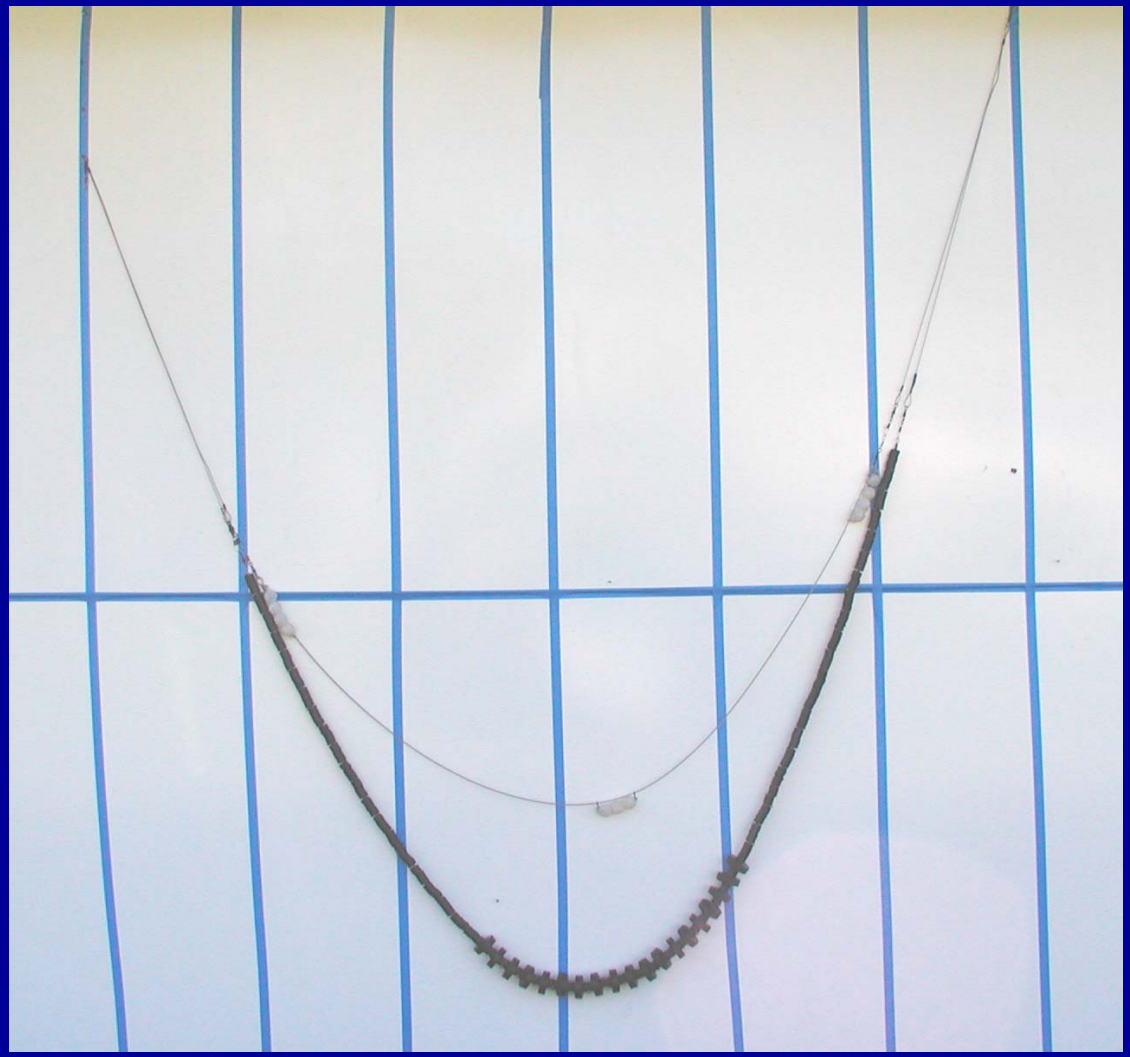
3 foot Offset in Warp Length



6 foot Offset in Warp Length



9 Foot Offset in Warp Length



Results of Literature Search

- Over 100 citations in books, journals, trade magazines, and gray literature.
- Most not relevant to either the general or specific questions previously identified.
- Several papers address the general questions regarding trawl performance.
- One chapter in book addresses the effect of warp length offset.

Summary of Literature Search (contd.)

- Doubleday and Rivard. 1981. Bottom Trawl Surveys. Can. Spec. Pub. 58. 273 p.
  - Sampling Techniques:
    - Fish Catching Process
    - Catch Variability due to Variations in Trawl Behavior
    - Factors Affecting Variability of Trawl Surveys

Results and Conclusions: (Doubleday and Rivard)

- Trawl is a quantitative sampling tool that must be calibrated, but even so there will be variable catch efficiency.
- Measurement variability due to vessel, fishing gear and environmental factors.
- Impossible to separate variability due to fish distributions from measurement error.

Summary of Literature Search (contd):

- Lauth, Syrjala, and McEntire. 1998. Effects of Gear Modifications on the Trawl Performance and Catching Efficiency of the West Coast Upper Continental Slope Groundfish Survey Trawl. Marine Fisheries Review 60:1-26.

Results and Conclusions: (Lauth, Syrjala and McEntire)

- Experiment distinguishes between engineering performance and catch efficiency.
- Treatments were door-bridle rigging, ground gear weight and scope length.
- All treatments affected engineering performance.
- Few treatments affected catch efficiency.

Summary of Literature Search (contd):

- DeAlteris, Recksiek and others. 1989. Comparison of the Performance of Two Bottom Sampling Trawls. Trans. Amer. Fisheries Society 118:119-130.

Results and Conclusions: (DeAlteris, Recksiek and others)

- Compared two designs of scientific sampling trawls, with various rigging and operational parameters.
- Measured geometric performance and catch efficiency.
- Found net design, rigging and operation all affected trawl geometric performance, but most treatments did not affect catch efficiency.

Summary of Literature Search (contd.)

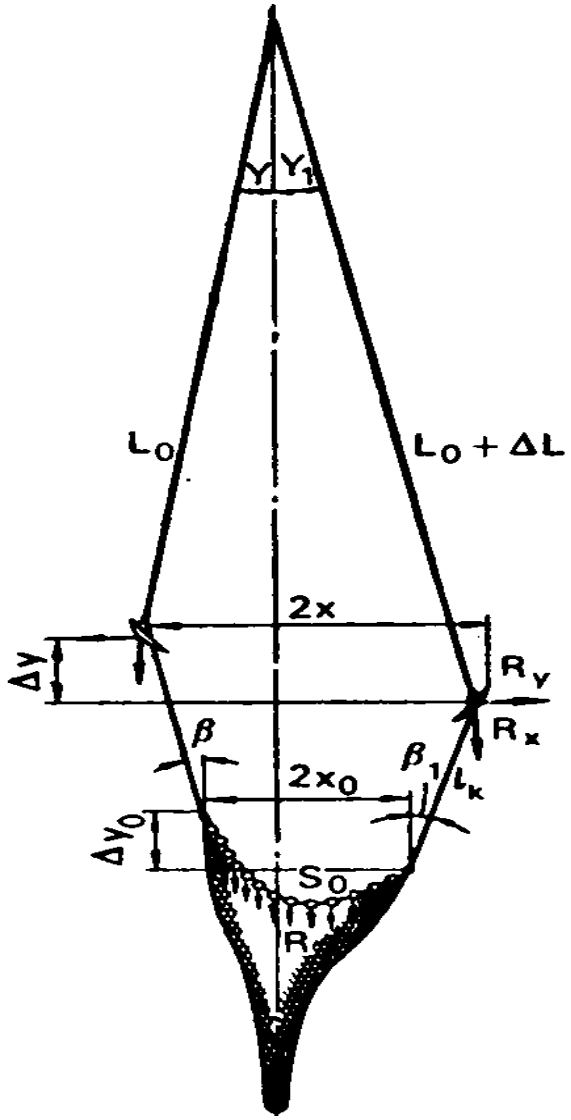
- Kondratev. 1973. Modeling of Commercial Fishing Gear by the Method of Analog Mechanisms. Translated form Russian.
  - Chapter: Effect of Difference in Warp Length on the Working of a Trawl.

Question Addressed: (Kondratev)

- "When a trawl breaks down fishermen usually first verify the warps."
- "Can we justify such demands on warps and the associated loss of fishing time to re-measure the warp?"
- "To answer this question, tests where made on a 31m (96 feet) trawl".
  - -Model tests
  - -Full scale fishing trials

Warp Length Offset Problem

Fig. 48. Distortion of trawl for varying warp scope.



Results and Conclusions: (Kondratev)

- Conducted model and full scale fishing evaluations.
- Results of model experiments indicate that trawl mouth geometry is only affected when “the difference in warp length exceed 20% of the length of the headline”.
- On the Yankee 36 trawl net, this would be 12 feet.

Results and Conclusions: (Kondratev, contd.)

- Conducted model and full scale fishing evaluations.
- Results of full scale experiments on the “1 RB-99 with a difference in warp length up to 15% of the length of the headline, the distance between the trawl boards and the fishing efficiency did not change appreciably”.
- On a Yankee 36 trawl net, this would be 9 feet.

Results of Canvass of Professionals in Fisheries Technology

- More than 75 individuals were contacted both nationally and internationally.
- Of those that responded, most had some experience with the general survey trawl performance problems.
- A few had real experience with the specific question, and could offer advice.

Advice and Experience of Experts

- M. Ben-Yami of Israel- Warp offset of 6 feet or more may be problematic. There may be a catch difference of 10-15 %, but it will be difficult to measure.
- C. Goudey of MIT- Observed the effect of small offsets in model nets, but difficult to obtain reliable results in model testing.

Advice and Experience of Experts

- Lee Alverson of NRC Consultants- Offsets of up to 6 feet should have minimal impact on catch. Recalled some experiments on the R/V Cobb in the 1970s on the west coast, small offsets had no effect on catch.
- Dick Ferro of Marine Laboratory, Aberdeen, Scotland- An offset will affect ground gear tension, thus affect sweep contact, and may affect catch efficiency.

Advice and Experience of Experts

- Steve Walsh of Canadian DFO- Suspects that there is little effect on catch with small offsets, but to confirm this will require many paired tows of standard and altered configuration gears.

Advice and Experience of Experts

- Gary Loverich of Ocean Spar, formerly NETS, and NMFS.-
  - Proposes that the offset must be considered in the context of the entire length of ground gear and sweep.
  - A 6 foot offset is 4.4% of this on the Yankee 36 survey trawl net.
  - The result of the offset is a skewed footrope, that may be elevated in sections.

Advice and Experience of Experts

- Gary Loverich of Ocean Spar, fomerly NETS, and NMFS. (contd)
  - Results of model tests suggest up to a 5.5% offset would not result in a catch reduction.
  - Auto-trawl winches often result in a 1-2% offset required to balance warp tension.
  - Other operational factors result is a skewed net.

Advice and Experience of Experts

- Gary Loverich of Ocean Spar, fomerly NETS, and NMFS. (contd)
  - Conclusion: “looking at all the evidence available to me, I believe that a warp differential on the order 5% would not greatly impact the cumulative catch of the Yankee 36 used aboard the R/V Albatross.”

Summary and Conclusions (I)

- A trawl warp length offset is another source of measurement error.
- The magnitude of the error is a function of the relative magnitude of the offset to the length of the headrope or ground gear and sweep.

Summary and Conclusions (II)

- General consensus of those who have attempted to measure the effect is that a warp length offset of up to 6 feet on the R/V Albatross IV using the Yankee 36 will minimally affect catch efficiency. Offsets greater that 6 feet become increasingly problematic in terms of catch efficiency. Although, this may be also difficult to measure.

Effect of Trawl Warp Offset

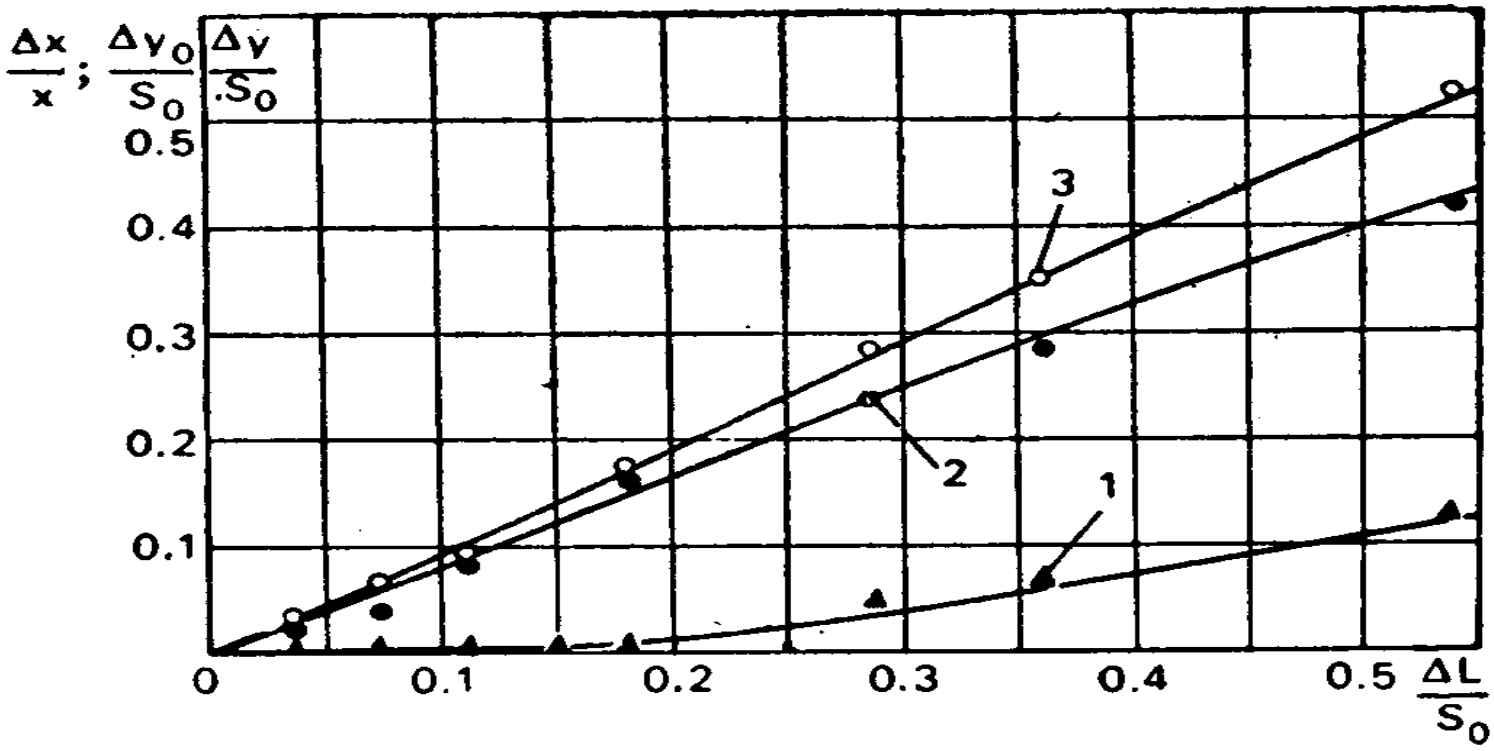


Fig. 49. Dependence of trawl distortion on difference in warp scope:

$1 — \frac{\Delta x}{x}$; $2 — \frac{\Delta y_0}{S_0}$; $3 — \frac{\Delta y}{S_0}$.